

WHAT IS CLAIMED IS:

- 1 1. A hydraulic control apparatus for a vehicle having an engine, the hydraulic control apparatus comprising:
 - 3 a belt-drive continuously variable transmission (CVT) including a primary pulley and a secondary pulley, each of the primary and secondary pulleys having a cylinder chamber to which an oil pressure is supplied and defining a groove variable in width corresponding to the oil pressure, and a belt engaged with the groove to transmit rotation of the primary pulley to the secondary pulley, the belt-drive CVT being operative to continuously vary a transmission ratio by changing the width of the groove;
 - 12 an oil pressure source operative to produce an oil pressure supplied to the belt-drive CVT, the oil pressure source being adapted to be driven by the engine;
 - 15 a pressure regulator valve operative to regulate the oil pressure produced by the oil pressure source;
 - 17 a controller programmed to develop a transmission control signal, the transmission control signal including a high speed transmission control signal for changing the transmission ratio to a high speed side and a low speed transmission control signal for changing the transmission ratio to a low speed side;
 - 23 a transmission actuator operative to be driven based on the transmission control signal;
 - 25 a first oil passage for supplying the oil pressure regulated by the pressure regulator valve;
 - 27 a second oil passage for supplying the oil pressure regulated to the cylinder chamber of the primary pulley and draining the oil pressure from the cylinder chamber of the primary pulley;
 - 31 a third oil passage for draining the oil pressure within the cylinder chamber of the primary pulley;

33 a fourth oil passage downstream of the pressure
34 regulator valve; and

35 a transmission control valve operative to be actuated by
36 the transmission actuator for controlling the oil pressure
37 within the cylinder chamber of the primary pulley, the
38 transmission control valve including a first port
39 communicated with the first oil passage, a second port
40 communicated with the second oil passage, a third port
41 communicated with the third oil passage, and a spool having
42 a block position where fluid communication between the first,
43 second and third ports is prevented, a high speed side
44 transmission position where the first port is fluidly
45 communicated with the second port when the transmission
46 actuator is driven in response to the high speed
47 transmission control signal, and a low speed side
48 transmission position where the second port is fluidly
49 communicated with the third port when the transmission
50 actuator is driven in response to the low speed transmission
51 control signal, the spool cooperating with the transmission
52 actuator and the primary pulley to form a mechanical
53 feedback mechanism for returning the spool to the block
54 position in response to change in the width of the groove of
55 the primary pulley,

56 wherein the third oil passage is connected with the
57 fourth oil passage to supply an oil pressure to the cylinder
58 chamber of the primary pulley and establish a minimum oil
59 pressure required for clamping the belt depending on
60 reduction of the oil pressure within the cylinder chamber of
61 the primary pulley.

- 1 2. The hydraulic control apparatus as claimed in claim 1,
- 2 wherein the vehicle includes a torque converter disposed
- 3 between the engine and the belt-drive CVT so as to increase

4 torque of the engine, a lockup clutch allowing direct
5 coupling of the engine and the belt-drive CVT, an oil cooler,
6 and lubrication parts, the hydraulic control apparatus
7 further comprising:

8 a torque converter regulator valve disposed downstream
9 of the pressure regulator valve, the torque converter
10 regulator valve being operative to produce a torque
11 converter pressure and a lockup clutch applying pressure and
12 a lockup clutch releasing pressure to be supplied to the
13 lockup clutch;

14 wherein the fourth oil passage is a cooler-lubrication
15 oil supply passage for supplying an oil pressure drained
16 from the torque converter regulator valve to the oil cooler
17 and the lubrication parts.

1 3. The hydraulic control apparatus as claimed in claim 1,
2 wherein the vehicle includes a start clutch operative to be
3 applied when the vehicle is started, a torque converter
4 disposed between the engine and the belt-drive CVT so as to
5 increase torque of the engine, and a lockup clutch allowing
6 direct coupling of the engine and the belt-drive CVT, the
7 hydraulic control apparatus further comprising:

8 a clutch regulator valve operative to regulate an oil
9 pressure drained from the pressure regulator valve and
10 produce a start clutch applying pressure to be supplied to
11 the start clutch; and

12 a torque converter regulator valve operative to
13 regulate an oil pressure drained from the clutch regulator
14 valve and produce a torque converter pressure and a lockup
15 clutch applying pressure and a lockup clutch releasing
16 pressure to be supplied to the lockup clutch;

17 wherein the fourth oil passage is a lockup clutch oil
18 supply passage for supplying the lockup clutch applying

19 pressure and the lockup clutch releasing pressure to the
20 lockup clutch.

1 4. The hydraulic control apparatus as claimed in claim 3,
2 wherein the lockup clutch oil supply passage is communicated
3 with an oil passage connecting the clutch regulator valve
4 and the torque converter regulator valve.

1 5. The hydraulic control apparatus as claimed in claim 1,
2 wherein the vehicle includes a start clutch operative to be
3 applied when the vehicle is started, and a lockup clutch
4 allowing direct coupling of the engine and the belt-drive
5 CVT, the hydraulic control apparatus further comprising:

6 a clutch regulator valve operative to regulate an oil
7 pressure drained from the pressure regulator valve and
8 produce a start clutch applying pressure to be supplied to
9 the start clutch;

10 wherein the fourth oil passage is a start clutch oil
11 supply passage for supplying the start clutch applying
12 pressure to the start clutch.

1 6. The hydraulic control apparatus as claimed in claim 5,
2 wherein the start clutch oil supply passage is communicated
3 with an oil passage connecting the pressure regulator valve
4 and the clutch regulator valve.

1 7. The hydraulic control apparatus as claimed in claim 6,
2 wherein the oil passage connecting the pressure regulator
3 valve and the clutch regulator valve is communicated with
4 the first oil passage.

1 8. The hydraulic control apparatus as claimed in claim 1,
2 wherein the first oil passage is communicated with an oil

3 passage connecting the oil pressure source and the pressure
4 regulator valve to supply the oil pressure produced by the
5 oil pressure source to the pressure regulator valve.

1 9. The hydraulic control apparatus as claimed in claim 1,
2 further comprising a link connecting the transmission
3 actuator, the spool and the primary pulley, the link forming
4 the mechanical feedback mechanism together with the
5 transmission actuator, the spool and the primary pulley.

1 10. The hydraulic control apparatus as claimed in claim 1,
2 wherein the transmission actuator is a stepping motor.